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(Forest Series, No. 1.)

THE

AGRICULTURAL LEDGER.

1895—No. 1.

ACACIA CATECHU.

CATECHU OR CUTCH, AND KATH.

[*DICTIONARY OF ECONOMIC PRODUCTS, Vol. I., A. 135–199.*]

Review of the Proceedings of the Government of India (Forest Department) on the subject of the isolation of Catechu *and of* Kath *from the wood of* Acacia Catechu—*by* THE EDITOR.

CALCUTTA:
OFFICE OF THE SUPERINTENDENT, GOVERNMENT PRINTING, INDIA.
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The objects of THE AGRICULTURAL LEDGER are:—

(1) To provide information connected with agriculture or with economic products in a form which will admit of its ready transfer to ledgers;

(2) To secure the maintenance of uniform ledgers (on the plan of the Dictionary) in all offices concerned in agricultural subjects throughout India, so that references to ledger entries made in any report or publication may be readily utilised in all offices where ledgers are kept;

(3) To admit of the circulation, in convenient form, of information on any subject connected with agriculture or economic products to officials or other persons interested therein;

(4) To secure a connection between all papers of interest published on subjects relating to economic products and the official Dictionary of Economic Products. With this object the information published in these ledgers will uniformly be given under the name and number of the Dictionary article which they more especially amplify. When the subject dealt with has not been taken up in the Dictionary, the position it very possibly would occupy in future issues of that work will be assigned to it.

E. C. BUCK,

Secretary to the Government of India.

(Forest Series, No. 1.)

THE

AGRICULTURAL LEDGER.

1895—No. 1.

ACACIA CATECHU.

[*Dictionary of Economic Products, Vol. I.*, A. 135—199.]

Review of the Proceedings of the Government of India (Forest Department) on the subject of the isolation of **Catechu** *and of* **Kath** *from the wood of* **Acacia Catechu**—*by* THE EDITOR.

The Extracts derived from Catechu tree.

The present review is intended to make known recent information on the subject of Catechu and thus to amplify and correct the account of that substance as given in the Dictionary of Economic Products which was published in 1884. In that article opportunity was taken to impress on the reader that there exists two, if not three, extracts, obtained from the Catechu tree, which in India are known as (*a*) dark Catechu or Cutch, (*b*) pale Catechu or *Kath*, and (*c*) a natural product found within the wood known as *Kirsal*. It was suggested that a more careful examination of these trade products might reveal their independence chemically, and accordingly that the Indian experience might be found to be more than due to mere variation in degree of purity. That suggestion led to an enquiry throughout India and to the performance of certain chemical investigations both in Europe and in India. Before proceeding to review the new facts that have thus been brought to light, the writer thinks it may serve a useful purpose to give here a brief abstract of his original statements and opinions, without which the subsequent particulars might be unintelligible to persons who had not the opportunity of consulting the original.

I.—PREPARATION OF DARK CATECHU, or, as in trade, it is more correctly designated CUTCH.

Trees suited for extraction of Cutch.

The trees that yield this substance are regarded as mature when about a foot in diameter. They are then felled and cut up into blocks two or three feet long. In some parts of the country the Natives ascertain whether it will pay to cut the trees, by making a small notch into the heart-wood. Trees between twenty-five and thirty years old are regarded as best suited and are said to yield more or less according to the number of white lines perceived in the heart-wood. The bark and the outer sap wood are generally removed and rejected. The red heart-wood is then cut up into small chips. In certain districts the branches are not utilized in the preparation of the extract, in others they are so used.

Mode of extraction.

The chips are then boiled in water in earthen pots for twelve hours. When the water is reduced by one-half, the chips are taken out and the liquid placed in large iron pans or cauldrons and again boiled and stirred till it attains the consistency of syrup. The cauldrons are then taken off the fire and the stirring of the liquid continued till the mass is cool enough to be handled, when it is taken out and spread on leaves arranged within a wooden frame or mould and left for the night. In the morning the Cutch is dry and then exists as brick-like masses that each weigh 36 to 44lb. These are broken up into pieces ready for the market.

The process of boiling and preparation of the dry extract varies considerably all over the region where the article is made, but the principle is the same as that given above, which may be said to be the Pegu system. Occasionally the chips are boiled a second time with the production of a small amount of inferior stuff. In other cases the red liquid is poured over fresh chips and again boiled.

The stirring or beating process.

From the widespread conviction of the necessity for stirring or beating the concentrated solution (on its being removed from the fire), it might almost be inferred that some chemical change was thereby effected similar to the oxidation produced by beating the indigo-vat solution. Thus, for example, in Baroda the decoction is strained through a blanket. For this purpose the blanket is dipped into the fluid, stirred about and then wrung out, while the blanket is being held at as great a height as possible. By this process the liquid falls through the air in a greatly divided stream or shower. And this is continued for an hour or so, the liquid being repeatedly wrung through the blanket, the trough is then covered over with a lid of split bamboos and the sediment allowed to subside. The water is then poured off and the extract cut into small cakes and allowed to dry.

In Bariya (Gujarat) the thick decoction is poured into pits, five or six feet deep, in the bottom of which baskets are placed. The liquid drains off, the chips are retained in the baskets, and the solid extract formed on the floor of the pits. This is removed and dried on leaves while exposed to the sun.

Stirring: *Conf. with p. 7.*

Speaking of the Pegu system, it is admitted that much difference of opinion prevails as to the value and extent necessary of the beating process. One writer says it is more of a "beating up" than stirring, "but I have never been able to ascertain what the object or effect of the process is. Cooks differ, too, in the amount of beating up that is desirable, some being satisfied with half an hour's application." It will be seen below in connection with the subject of *Kath* that a peculiar system of encouraging crystallization (which may be analogous to the beating) is considered essential.

Season for manufacturing Cutch.

In Pegu the manufacture of this article extends from June to March, but the months of December to March are regarded as the best. In April and May scarcity of water is supposed to stop the works, while in the rainy season the difficulty of transport checks the industry.

Yield. As to the amount of Cutch yielded by heart-wood, it had been stated that from 3 to 10 per cent. in weight would be a good average. In other words, one ton of timber, in the round, might be taken as yielding 250 to 300lb of Cutch.

Appearance of Cutch. The Cutch of trade appears in several forms. The Pegu variety occurs in masses with layers of leaves between the successive preparations. But Cutch is also met with in cubes of various sizes which often show the markings of leaves used in the moulds, or it occurs in sharply defined cubes or blocks from having been cut up by a string or wire run through the still plastic mass. In other cases it is sold in rounded balls or flattened cakes made in the hand.

In colour it is externally of a rusty brown, internally a dirty orange to dark liver-colour, and in some cases almost black or port-wine coloured. It is inodorous, but has an astringent bitter taste, followed by a sense of sweetness. It is brittle and breaks with a more or less resinous, shining fracture.

II.—Preparation of Pale Catechu or Kath.

Preparation of pale Catechu or Kath. This is a crystalline substance prepared from a concentrated decoction of the wood by a slightly modified process to that described for Cutch. A bunch of twigs is placed in the hot solution and the pots are then set on one side to cool. The twigs are subsequently removed and the crystalline substance adhering to them is collected and compressed into cubes of various sizes. Whether or not the liquid is rejected or afterwards boiled down to produce a poor quality of dark Catechu or Cutch does not appear to have been ascertained. The crystalline substance *kath*, as met with in the bazars, occurs in irregular pieces, in square blocks or in cubes similar to those of gambier. This is the substance eaten by the Natives of India in *pán* and it is (at least in its purer forms) never exported.

Conf. with p. 14. It seems probable, however, that there may exist an industry practised more or less as a secret in various parts of India, in preparing the crystalline article *kath* from the cruder substance Cutch, since its direct preparation from the original decoction has only been observed in Kumaon, though the substance is universally used all over India and fetches a higher price in the bazars than does Pegu Cutch.

This subject deserves to be thoroughly investigated, and the merits of *kath* and its process of manufacture made known. The dark and the pale forms of *khadira* were both well known to the early Sanskrit writers, but in modern times, and especially in the European export trade, they seem to have been confused, with the result very possibly of gambier having been substituted for catechu in European medicine.

III.—Kírsal or Khersal.

Kirsal. The woodmen when cutting up the trees to prepare the chips employed in boiling for Cutch and *Kath* sometimes come across a substance imbedded in the wood which they carefully remove and sell under the name of *kirsal*. It is much valued by the Hindus and fetches a high price. It has apparently never been chemically examined, but is possibly a pure state of Catechin.

ACACIA Catechu.

The Isolation of Cutch,

Chemists, opinion.

The following passages from the Dictionary of Economic Products may be here republished as exhibiting the opinions of some of the leading chemists prior to 1884:—

"Catechu contains a variety of tannic acid called *Mimotannic acid*, which is soluble in cold water, and *Catechu* or *Catechuic* acid, which is insoluble. Mimotannic acid differs from tannic acid in yielding a greenish-gray precipitate with ferric chloride, and by not producing pyrogallic acid when heated. The destructive distillation of Cutch yields *Pirocatechin*. Quercetine is stated to be contained in Cutch. This principle is the yellow crystallizable substance to which the bark of **Quercus tinctoria**, *Oliver*, owes its colour." (*Dr. C. F. Hislop Warden.*)

The chemistry of the Catechus has occupied the attention of chemists for some time back, but as yet the views and conclusions arrived at are somwhat conflicting, and the subject may be regarded as still involved in considerable obscurity. The brief chemical note (above), which my friend Dr. Warden has supplied, may be regarded as an abstract of all that is known. In his *Science Papers*, the late Mr. D. Hanbury suggests that the process by which the various kinds of Cutch, Catechu, and Gambier are obtained should be carefully studied by persons who have the opportunity of doing so on the spot, and that the trees yielding each of the forms of these substances should be accurately recorded; "for," he adds, "we wish to identify the trees with the respective extracts." It would seem that our ignorance upon these important points may have much to do with the conflicting chemical results which at present exist regarding the composition of Cutch. There are at least two, if not three, distinct products obtained from each of the Cutch-yielding trees, and it is just probable these may have been experimented upon indiscriminately by the chemists of Europe. It would be but in keeping with other instances of two or more species (still more so of members of different Natural Orders of plants), yielding approximately the same product, to find that the trees which afford the Cutch of commerce produce substances chemically dissimilar. Some such explanation may be found in the future to account for a certain number of the conflicting opinions which at present exist regarding the chemical composition of Cutch and its derivatives. A similar example may be mentioned in the fact that **Aconitum Napellus** yields a different alkaloid from **A. Ferox**, although both species have hitherto been used in the preparation of Aconitia.

Pegu Catechu, "when immersed in cold water, turns whitish, softens, and disintegrates, a small proportion of it dissolving and forming a deep-brown solution. The insoluble part is Catechin in minute acicular crystals" (*Flück. and Hanb., Pharmacog, 243*). When the crude Cutch of commerce is subjected to a dry heat of 110° or 100°, in an atmosphere of hydrogen, it fuses and becomes transparent, losing 4 to 5 per cent. of its weight. It melts at 140° without further loss of water. On ignition there is left 3 to 4 per cent. of ash. If pure, it should be completely soluble in boiling hot water, the solution precipitating the insoluble crystals of catechuic acid on cooling. Ether extracts from Cutch its catechin or catechuic acid, so that by precipitation from a hot solution, or by means of ether, this substance may be separated for chemical or industrial purposes.

Conf. with Warth's analysis, pp. 7, 9.

In addition to catechin, Cutch contains, however, other two substances, *viz.*, Mimotannic acid *plus* a gummy extractive principle (=Catechu tannin). Mimotannic acid is soluble in cold water, and by simple maceration may, therefore, be removed from Cutch. The solution will be observed to be of a thick chocolate colour. If heated to the boiling point, it is rendered quite transparent, becoming turbid on cooling. With this

Chemistry of Catechu.

solution ferric chloride gives a dark-green precipitate, which will immediately change into purple on the addition of cold water, or of an alkali.

Catechuic and Mimotannic acids are said to be present in Cutch in about equal proportions. The effect of heat upon Cutch and its compounds is most important, and, as pointed out by Etti, the chemical changes effected by heat afford the most likely explanation of the discordance of authors as to the formula for Catechin. According to Loebermann, confirmed by Etti's re-examination of the substance, the formula for Catechuic acid or Catechin is $C_{18} H_{18} O_8$. If a piece of Cutch be first heated in a crucible and then macerated it will be found to be completely soluble in cold water. This is explained by Etti as due to the formation of soluble anhydrides from Catechin, thus:

$$2 (C_{18} H_{18} O_8) = 2H_2 O + C_{36} H_{32} O_{14} \text{ or } 2 \text{ (Catechin)} + \text{heat} = 2 \text{ (water)} + \text{Catechu tannin.}$$

The compound thus produced is known as *Catechu-tannic acid*, and is completely soluble in cold water. By a further loss of water at 190°-200° this becomes $C_{36} H_{30} O_{15}$. Under the influence of heat the anhydride that is first formed is $C_{36} H_{34} O_{16}$, an insoluble, brownish-red, amorphous powder, a substance soluble in alcohol and precipitated in crystals by lime-water. These compounds, if formed in varying proportions in a piece of Catechu, would greatly tend to produce conflicting chemical formulæ in the results of different experiments, and *a piece of Catechu which is found to be completely soluble in cold water should be regarded as inferior in quality* (injured through heat) and most probably adulterated by the trader.

For some time Gautier regarded the Catechin of Gambier as quite distinct from that obtained from Catechu, but in his more recent publications he admits them as identical. He now corrects his formula, $C_{19} H_{18} O_8$ which he published as expressing Catechin (adopted in *Flück. and Hanb., Pharmacog.*), into $C_{19} H_{20} O_8$ and suggests for this compound the name of *Methylcatechin*.

The soluble Catechu-tannic compounds constitute the active stringent principle of the drug and the tanning and dyeing property for which it justly holds so high a position for industrial purposes.

Solubility: *Conf. with pp. 2, 7, 13.*

Preparation of Pure Catechin.—Etti directs that Catechu should be dissolved in about eight times its own weight of boiling water, and the liquid, after being strained through a cloth, should be set aside for some days until the insoluble Catechin subsides. This should then be collected and placed under a screw-press, being thereafter dissolved in a sufficient amount of dilute alcohol and the filtered solution shaken up in ether. The ether is next removed by distillation, and the crystals obtained washed repeatedly in pure distilled cold water. It is then found to exist in the form of almost colourless crystals.

Adulteration.

Adulteration and Detection of Catechu.—Meyer regards ether as the best re-agent for this purpose. Whether it has been partially heated or not, the whole of the Catechu-tannic compounds may be abstracted from a given weight of pulverised Cutch by repeated treatment with ether, about 53 per cent. of the original weight being thus removed. The dried residue should thus weigh about 47 per cent., the excess over this being adulterants. The chief substances used for adulteration are sand, clay, sugar, starch, and dried blood. On ignition pure Cutch should leave a residue of 3 to 4 per cent. It should be completely soluble in boiling hot water; if soluble in cold water, it may be suspected of impurities or of having been injured by heat.

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Necessity of Chemical examination urged.

The Dictionary of Economic Products (from which the above abstract has been taken) thus advocated the necessity for a careful chemical examination of the actual samples met with in trade as being likely not only to remove the defective knowledge that has retarded progression and prevented economies in manufacture, but as calculated to reveal the existence of widely different chemical substances in certain forms of the commercial article. It also thus exhibited the injurious action of heat in reducing Catechin and manifested a simple method of separating Catechin from Catechu tannin, owing to the latter being soluble in cold water. It was also assumed that *Kath* and still more so *Kirsal* might be found to be fairly pure states of Catechin, while Cutch would be revealed as a crude article mainly consisting of Catechin tannin. The higher price paid in India for *Kath* might be admitted as very naturally suggesting the still further enquiry as to the discovery of simple methods of separating these substances; in other words, of preventing the reduction of Catechin to Catechu tannin, if not of raising the latter to the former state. This much-to-be-desired result has not as yet been attained and there are chemists who even affirm that it is impossible. But investigations of the nature indicated might have naturally led to these substances being placed on the market separately, since by so doing they would meet independent industrial purposes, if indeed it were not found to be the case that the higher price paid for pale Catechu would allow of the residual product (or by-product) being sold at a considerably lower rate than at present without very materially reducing its industrial value and, to thus provide a means whereby the technical industries could use the two articles separately or in fixed combinations where a mixture of the two was found necessary.

Separation by heat. *Conf. with pp. 4, 5.*

Conf. with p. 5.

Were it possible to establish this double manufacture, then Etti's observation that Cutch, which is entirely soluble (that is to say Cutch that contains no Catechin), is of less value, would have to be accepted as the character of that article.

These, then, were some of the opinions and expectations formed by the Editor when he compiled in 1884 the account of Cutch or Catechu that will be found in the Dictionary. On the Inspector-General of Forests having had his attention directed to the above views, an enquiry was at once instituted and certain chemical investigations conducted. The passages below may be accepted as a brief review of the new information thus brought to light.

The following three reports were submitted to the Government of India through Her Majesty's Secretary of State for India:—

WARTH'S REPORT.

Reports on the yield of Catechin from five different qualities of the wood of **Acacia Catechu** *in Oudh and Burma—by* Dr. H. Warth.

(1.)

12th March 1890.

Wood with white spots.

"Early in 1889 an inquiry was started why the professional makers of *kattah* refused 'Khair wood' without white spots, and only worked up those stems which were found to have white spots scattered all through their heart-wood. It was reported that the makers of *kath* cut into the

trees for the purpose of examination, and leave those stems unused which show no white spots. Much damage is thus done to the forests. WARTH'S REPORT.

"A preliminary examination in India showed that the wood with spots yielded more extract than the wood without spots. The relative yield of *kath* was, however, not so easily determined, and I offered to inquire more thoroughly into the matter during my furlough in Europe. I have, for this purpose, been provided with samples of wood and with extracts made by the *kath* makers in Oudh and by the cutch makers in Burma; also with printed notes on catechu and its manufacture in India.

"I find, also, much information on record in Europe about cutch or catechu, also gambier or *Terra Japonica*; but much uncertainty exists about the composition and properties of the principal compounds, catechin and catechu tannin. No record exists of any examination of wood which yields the cutch.

"The active principle of cutch is the tannin—that variety of tannin which is called Catechu-tannin, and which forms a greenish-brown compound with ferric salts. As a rule there is, however, also Catechin in the cutch. *Kath*, which is used in India for consumption with betel and lime, has catechin for its active principle. Pure *kath* is almost entirely catechin. Catechin and catechu tannin are similar in composition, and resemble each other in some of their properties. *Catechin is easily changed into tannin or a similar substance, but not the reverse. Catechin is soluble in hot water, and practically insoluble in cold water.* The tannin dissolves in water of any temperature. Active principle of Catechu. *Conf. with this the remarks on solubility, pp. 4, 5.*

"This different behaviour towards cold water enables us to separate the two substances from each other. Yet this operation is not as easy as might be thought, because the tannin in the solution retards the separation of the catechin. After long standing of concentrated extracts of the **Acacia Catechu** wood, which are mixtures of catechu tannin and catechin, all the catechin is not separated. Some appears always to remain in the final residue with the tannin.

"Two extracts, A and B, were made in Burma from the woods named A and B, and sent as prepared samples of catechu with the wood specimens. I treated these samples very carefully with acetic ether and with hot water, but I was only able to obtain 6 per cent. of catechin from them, whilst catechu is generally supposed to contain more catechin than that. Experiments with Cutch.

"When trying to extract and crystallize catechin out of small quantities of the wood of **Acacia Catechu**, complete failure is the result if the solutions are diluted, and if the wood is boiled and treated for a long time with the object of making the extraction complete. *A rapid treatment and concentrated solutions are indispensable.* The following method may be followed:—

"About two ounces of finely cut wood are boiled for half an hour with twenty times their weight of water. The decoction, freed from the wood, is reduced in bulk on the water bath until it begins to become syrupy, or until it is estimated to contain about 6 per cent. of catechin. The liquid is then allowed to stand in a cool place for four days, or at the most five days. The catechin never separates at once. Even cooling to freezing point has no effect, but after standing a night there is separation in most cases. When the proportion of catechin is small in comparison with catechu tannin, it may happen that it takes two days until the separation begins, and in such cases it will be good to let the liquid stand five days. *Stirring the liquid is advisable. Immediate crystallization of catechin is sometimes effected by the addition of some ready crystallized catechin to the over-saturated solution and stirring.* The addition of a drop of mineral acid has also sometimes the effect of making the catechin separate. Stirring *Conf. with p. 2.*

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The chief agent in this process of separation is, however, time. After enough time has been allowed, the catechin is brought on a filter and roughly washed with cold water. The catechin is then dried by exposure to dry air. The air must not have a higher temperature than 40 degrees centigrade. Heat injures or destroys the damp catechin. The accounts of the manufacture in India agree also about the drying of the product by air and not by artificial heat. After the catechin was completely dried in warm air, I left it for some time in the desiccator. When I weighed it, it had reached such a state of dryness that it kept increasing slightly in weight on the scale pan through absorption of moisture from the air.

Experiments with Cutch.

"Once the catechin is thus separated and dried, it remains unchanged for years, as is shown by the constancy of the *kath*. *The pure catechin, after being dissolved in hot water, separates immediately on cooling.* There is no such delay as in the case of mixtures of catechin and tannin. When dissolved in eight times its weight of hot water and then cooled, the catechin separates in such numbers of microscopcial crystals that the liquid becomes stiff.

"At the same time we notice how easily the *catechin is decomposed whilst in solution.* The recrystallization of catechin yielded, on the average of three trials, only 68 per cent. of the original weight. The original catechin was air-dry, and the second catechin was dried in the desiccator and was a little purer; but still the actual loss of catechin through the simple solution in hot water, crystallization, and drying cannot be less than 25 per cent.

"*If mere crystallization of catechin by means of hot water causes such a loss, it is not astonishing if the decoction of the wood with water does not yield the complete amount of the catechin.*

"The filtrate from the catechin is evaporated in the water bath, and the residue weighed. We thus know how much soluble matter was extracted from the wood, and find the proportion of catechin in the whole extract.

"Further treatment of the residue with the aid of acetic ether yielded often a little additional catechin. But it was not enough to affect the result much, and, as in some cases only the merest trace of catechin was obtained from the residue, the removal of catechin by the main process appears so far satisfactory.

"I made now with each of the woods a further trial. I treated a portion of finely cut wood with much hot water, so as nearly to exhaust all soluble matter. I desiccated the extract and weighed the residue. From this I obtained the maximum percentage of solubles in the wood. During the rapid extraction of catechin I obtained less total soluble matter, but I have also placed the figures on record for the purpose of comparison.

Yield from different woods.

"From the average proportion of catechin in the extracts and from the maximum yield of extract of each wood, we calculate then the maximum yield of catechin of each. The following samples of the wood of **Acacia Catechu** were examined :—

"Oudh No. I.—Reported by the *kath* makers as unfit for making *kath*. One in a thousand of the large pores of the heart-wood filled with white substance.

"Oudh No. II.—Reported as good for *kath*. About one in six of the large pores filled with white.

"Burma A.—Reported by the Burmese as having no white spots. Has no spots, but cracks filled with white matter (*kirsal*).

"Burma B.—Reported by the Burmese as having spots. One in twenty of the pores white.

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"Burma C.—Selected by the Forest Officer as having distinct spots. A very beautiful specimen with large white spots. About one in every three pores white.

Yield from different woods.

"The following table shows the amount of extract obtained at different trials. The extract was of such dryness that it just began to increase a little in weight on exposure to the air:—

Wood.	Per cent. Extract.	Maximum per cent.
Oudh No. I.	6, 9, 10, 14	14
Oudh No. II.	4, 15, 15, 16, 17, 19, 23, 24	24
Burma A	12, 15, 17	17
Burma B	14, 15, 16	16
Burma C	16, 16, 20, 20	20

"The following table shows the amount of catechin separated out of the woods:—

Wood.	Percentage of Catechin in the Extract.	Mean per cent.
Oudh No. I.	33, 38	36
Oudh No II.	27, 31, 38, 64	40
Burma A	9, 19	14
Burma B	17, 46	31
Burma C	21, 36	28

"From the above we calculate the total yield of catechin in these five woods as follows:—

Oudh No. I.	= 5 per cent. catechin from the wood.
Oudh No. II.	= 9 " " "
Burma A	= 2 " " "
Burma B	= 5 " " "
Burma C	= 6 " " "

Wood with white spots rich in Catechin.

"We have thus ascertained the following facts. *Woods with white spots are richer in extract and richer in catechin* than those without spots. Of all woods, catechin may be extracted by the above-mentioned method with hot water. The Oudh woods are specially favourable for the manufacture of catechin. This explains why the manufacture of *kath* has specially developed in Oudh. *Kath* should be pure catechin, containing as little tannin as possible.

"I examined *kath* from Oudh, which was bought in the bazar at Dehra Dun, North-West Provinces. It consisted of rectangular pieces about 2 inches long. *The pieces are earthy inside, and they have all round their surface a hard crust, one-eighth of an inch thick, rich in tannin.*

"For the determination of catechin, I only took the inner soft portion of the pieces. Even this inner purest portion contained 3 per cent. of wood splinters and sand. The recrystallization yielded the following proportion of catechin—

34, 38, 48 per cent., or, on average, 36 per cent.

"The *kath* which was manufactured for the Oudh Forest Department, and sent to me with the samples of wood of **Acacia Catechu** early this year, yielded 62 per cent. catechin. It was, therefore, much richer and purer than the *kath* of the bazar. But still it contained also 4 per cent. of wood splinters and 2 per cent. of sand.

"It would now appear advisable that in the Oudh forests *both classes of trees should be utilized for the manufacture of kath and of catechu.* The inferior trees might be treated separately. If the manufacture could be centralized, it would be possible to use machinery for cutting up the

ACACIA Catechu. — **The Isolation of Catechu,**

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wood, and to carry on the whole work on a large scale and with improved appliances. *That portion of the extract which would remain over after the separation of the catechin could be utilised for making common cutch or catechu for the European market.*

"In Carl Feuerlein's factory, near Stuttgart, South American woods are used for making extracts of vegetable dyes, one of them very similar to catechu. The extraction is effected with hot water under ordinary pressure, and the decoctions are concentrated at lower temperature in vacuum pans. The vacuum increases the outturn because it prevents much of the dyeing material from being decomposed. The imported Burmese cutch is subjected to a purifying process, and also finally evaporated in vacuum pans. It is, therefore, possible that vacuum pans would also effect a saving in the manufacture of cutch in India."

Vacuum pans.

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(2)

CANNSTATT, WÜRTEMBERG, GERMANY;

11th August 1890.

"On the 12th of March last I had the honour to report on the amount of catechin and tannin contained in the wood of **Acacia Catechu** from Oudh and from Burma.

Yield from different woods.

"I found from 5 to 9 per cent. catechin and 10 to 15 per cent. tannin when using two or three ounces of the wood for each trial. To test my method further, I have now treated larger quantities—namely, 50lb of wood No. I. from Oudh, and 30lb of supposed No. II., which had both been sent to me by the Oudh Forest Department. I cut the wood on the lathe into shavings of $\frac{1}{16}$th inch thickness, and boiled two or three times with water. The liquid so obtained I concentrated over the fire and finally over the steam bath until it was dark brown and thick, and began to form skin at the surface. *I then let cool, and afterwards stirred it up with a trace of ready-made catechin. Finally it was allowed to stand for five days in a cool cellar, during which period the catechin crystallised out.*

"After dilution with cold water I put the liquid through the filter press. The cakes of catechin were then dried in the open air at ordinary temperature.

Preparation of both Kath and Cutch from same wood.

"The liquid which flowed off from the catechin was put to evaporate until it was nearly solid. It was then poured into a paper mould, in which it solidified. Of the produce so obtained I have the honour to submit samples according to the subjoined list.

"The Oudh wood No. I. is the poorer quality, from which the Oudh local *kath* makers declared they were unable to make *kath*, or impure catechin, I obtained 3·7 per cent. of dry pressed catechin (the purest *kath*) and 12 per cent. of pure hard catechu tannin.

Iron vessels to be avoided.

"The 30lb of Oudh wood No. II. were sent by the Forest Department evidently by a mistake. Instead of being the rich kind of wood with a large percentage of catechin, and recognized by white spots, they were a poor kind of wood, in which I could recognize but the merest trace of white spots. When boiling this wood, I also used an iron vessel, which I thought was not dangerous because it had been newly tinned, but the tinning was insufficient and iron rust got into the liquid. *Iron is such a great enemy in the manufacture of catechin that iron vessels, whether tinned or galvanized, will have to be absolutely avoided.* In consequence of this mishap with the iron, the supposed wood No. II. yielded me only 2 per cent. of catechin, besides 11 per cent. of catechu tannin, of both of

which I have the honour to submit samples. According to my former trials on a small scale, good wood No. II. might have yielded me 9 per cent. of catechin and 15 per cent. of tannin.

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"No serious mishap, however, took place with the 50lb of wood No. I., and it was of chief importance to prove the usefulness of this wood No. I. for catechin manufacture, *because the local makers refuse to use the wood, although it grows with the other in the same forests and is of the same species*, **Acacia Catechu.**

"I have now the honour to propose an improved method of making catechin and tannin in the North-West Provinces.

Suggestio for improv manufactu

"Whilst, according to the reports, the local *kath* makers cut into the heart-wood of the trees, and leave those trees standing injured and unused which have no white spots, it will be in the interest of the Forest Department if both trees, No. I. and No. II., are used up at the same time for the same purpose.

"The smaller yield of catechin from the trees No. I. will be compensated for by the manufacture of tannin for the European market. This catechu tannin will fetch its price there as a catechu of superior, uniform, and always trustworthy quality. From the wood No. II. the improved method will also utilize a large quantity of tannin or pure catechu, which has hitherto been wasted. The people pour their mixture of tannin solution and catechin upon sand, when the catechin remains and is dried into cakes, whilst the tannin soaks away into the sand.

Utilisation wood with without sp

"The catechin itself is also very impure. Taking the whole pieces of 6lb of *kath*, softening them with cold water, and putting them through the filter press, I obtained 59 per cent. of air-dry catechin cakes, 25 per cent. of tannin in solution, and 16 per cent. of sand. *For the imperfect and wasteful method of filtering through sand, it is proposed to substitute the filter press.* The filter press is now universally introduced for separating solid matter from liquids, and it is of special utility in the manufacture of catechin. The separation of catechin from the strong tannin solution by ordinary filtration is very difficult, and dilution causes loss of catechin, because the latter on standing with water becomes converted into a soluble substance. The filter press, which effects the separation of the catechin rapidly, is therefore quite indispensable. Its application alone will give quite a new start to the process of catechin extraction.

Improve filter.

"But the cutting up of the wood by machinery will also afford a great advantage over the present method of cutting it into coarse chips by hand. If we add, for earthen pots, large copper vessels for boiling the thin shavings of the wood and for concentrating the liquid, we have all that is required for the economical production of catechin on a large scale.

Cutting wood by machiner

"The final desiccation of the tannin solution from which the catechin has been separated would also be a difficult process if done in the ordinary way. It would require many hours of stirring, *because the hot thick liquid forms skin on exposure to air*, and it is only constant tearing of the skin which renders evaporation possible. For this part of the process it is therefore advisable that vacuum pans be used. By their means the evaporation will be accelerated, and the injury done to the tannin by the boiling will be reduced to a minimum.

Use of vacuum pa

"The complete apparatus for the improved process does not cost much. Mr. J. Gyiketta, an expert for dye and tannin extraction, has given me the following figures:—

The Isolation of Cutch,

"A manufactory for extracting 10 tons of wood daily consists of—

	£
2 steam boilers, each of 1,000 square feet heating surface	1,000
Setting up and chimney	250
1 steam engine of about 100 H. P. (or a turbine if there is water power)	600
2 wood cutting machines	200
6 copper vessels for extraction	450
2 copper vacuum pans, each with 500 square feet heating surface	600
1 air pump for the vacuum pans	250
1 filter pump of 100 square feet surface	200
Reservoirs	50
TOTAL	£ 3,600

"This sum is intended for Europe, and equals about ₹50,000 in Indian coin. No provision is made for sheds, houses, wells, etc., and there will be the cost of transport to India and to the site in the North-West Provinces. Many spare parts of machinery will also be required, to avoid delay in repairs. But all this and every possible expenditure, including the deputation of an expert for two years, will be more than met if we assume a total cost of one lakh of rupees.

"A factory costing one lakh of rupees will, in 200 working days per year, produce about 3,500 maunds of catechin and 7,500 maunds of tannin dye. The value of the former in India will be at least ₹1,10,000, considering its great purity, and the value of the latter in India for export to Europe will be about ₹90,000. The total value of produce per year will be about ₹2,00,000. The annual produce of the factory will, therefore, be worth twice the original cost of the factory.

"The conditions are, therefore, very favourable, and there is little doubt that private enterprise would readily step in if the case were made known, and it would be easy to overcome all competition and to obtain the monopoly for the manufacture.

"Catechin or *kath* is, however, an article of everyday use in almost every household in India, and there are reasons why it would be better that the Government of India should obtain this monopoly. Moreover, the Government are either in possession of the **Acacia Catechu** forests, or else they have the control over the production and supply of the wood; it is, therefore, quite suitable that the Government should undertake the work.

"I would be obliged if you would permit my coming to London before my return to India, that I may personally report on the subject and, if you advise, communicate with consumers of catechu and manufacturers of dyewood extracts in England for the purpose of proving still further the advisability of the proposed work."

ENCLOSURE.

List of Samples sent on the 9th of August by post via *Hamburg to the Under-Secretary of State.*

Wood of **Acacia Catechu**, No. I., one piece.
Wood of **Acacia Catechu**, No. II., one piece.

	Grammes.
Indian *kath*	125
Indian *kath*, taken through the filter press	600
Catechin from No. I. wood	560
Catechin from No. II. wood	290
Tannin from No. I. wood	770
Tannin from No. II. wood	350
Total weight of *kath* catechin, tannin	2,695

ACACI. Catech

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The whole was reported in the Customs sheet as 3 kilogrammes catechu."

(3)

December 1890.

"In Dr. Watt's *Dictionary of the Economic Products of India* we find it stated that the merits and the preparation of *kath* deserve to be thoroughly investigated. As I have had occasion to study the subject and to make experiments, it may be useful to record the following facts.

Kath and Catechu.

"The *kath* of the North-West Provinces which is used with pân, and the catechu of Burma which is exported to Europe as a dye-stuff, are both prepared from the wood of **Acacia Catechu**. The *kath* is in its purest state chiefly catechin, a crystallizing substance *nearly insoluble in cold water*. The catechu is chiefly catechu tannin, a substance *soluble in cold water and not crystallising*, but some catechin is usually mixed up with it. The difference between *kath* and catechu is partly due to the methods of manufacture, partly to the difference in the trees.

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Trees of different kinds & differen ages.

"The trees in Burma differ from those of the North-West Provinces, and in each place there are two kinds of trees, No. 1 and No. 2, although of exactly the same species. Trees No. 2 have white spots in the wood, caused by a white substance stored up in cylindrical masses half a millimetre thick and ten millimetres long. Trees No. 1 have no white spots. Trees with spots yield an extract richer in catechin, and both kinds of trees in the North-West Provinces yield more catechin than the corresponding kinds in Burma.

Yield of Catechin.

"I found the following proportions of catechin in the total extract:—

	Catechin.
Burma, No. 1	14 per cent.
" " 2 (spotted)	30 "
North-West Provinces, No. 1	36 "
" " " 2 (spotted)	40 "

"The greatest amount of extract obtained from each kind of wood was as follows:—

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	Extract.
Burma, No. 1	17 per cent.
" " 2 (spotted)	18 "
North-West Provinces, No. 1	14 "
" " " 2 (spotted)	24 "

"The greatest amount of catechin obtainable from these woods is accordingly as follows:—

	Catechin.
Burma, No. 1	2 per cent.
" " 2 (spotted)	5 "
North-West Provinces, No. 1	5 "
" " " 2 (spotted)	9 "

"Such a great proportion of catechin in the spotted wood of the North-West Provinces explains that *kath* manufacture is at home there. Moreover, the local *kath* makers are reported to refuse as unfit all trees which do not contain white spots, so that the trees No. 1 become wasted in the forests.

"I determined the catechin by direct separation as follows. About two ounces of the wood reduced to thin shavings were boiled, with twenty times their weight of water, for half an hour. The extract was separated from the wood by repeated settlement, and reduced in bulk on the water bath until it just began to thicken and contained by estimate 6 per cent. of

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catechin. It was then left to stand in a cool place for five days for the separation of the catechin. Once the catechin had separated, the liquid could again be diluted with cold water for the purpose of filtering. The filtered and roughly washed catechin was dried at ordinary temperature, and weighed in a thoroughly air-dry condition.

Separation of Catechin.

"The high degree of concentration and the long standing are required because the catechin separates with difficulty out of an extract which contains so much catechu tannin. Once the bulk of the tannin is separated, the catechin may be dissolved in much more water, and it will separate immediately on cooling; but the *catechin is at all times a delicate substance, which changes with water slowly into soluble substance and is thus lost. The drying of the moist catechin must take place at a low temperature, as heat at once destroys the microscopic crystals.*

Conf. with p. 25.

"The manufacture of *kath*, or raw catechin, is carried on in the forests with very primitive appliances. The filtering is done through layers of sand, and much sand becomes mixed up with the *kath*. The drying is performed in the open air.

"The people say that they possess a manufacturing secret; but there seems no need for one, unless their secret consists in the mixing of some finished catechin with the thick liquid, which sometimes promotes the separation of the new catechin. Anyhow, I made out of the 50lb of **Acacia Catechu**, No. 1, from the North-West Provinces, nearly 2lb of pure catechin, and it is from this wood that the *kath* makers of the North-West Provinces declared themselves incapable of making *kath*. For filtering larger quantities of catechin, I found the filtering press an excellent expedient. The pressed catechin dried in a few days from simple exposure to the air, and once dried the catechin is a very durable substance.

"*Contact with iron must be scrupulously avoided during the extraction of catechin.* With catechu or cutch contact with iron is of no consequence, and the reports mention iron caldrons in use for the final boiling down of the cutch in Burma.

Preparation of Cutch.

"The preparation of cutch or catechu is of course simpler than that of *kath*, because nothing but watery extraction of the wood is required and subsequent boiling down of the extract.

"After a certain degree of concentration, a skin forms over the surface of the hot liquid, and constant stirring for hours is required to effect the final desiccation. This long stirring process is also mentioned, but not explained, in the descriptions of the Burmese catechu extraction. In modern dye extraction works the stirring would be avoided by the use of vacuum pans."

The passages in the above which the Editor has ventured to render in italics seem worthy of special consideration as likely to have a direct bearing on any future expansion and improvement in the production of *Kath* and Cutch. **Dr. Warth's** observation that wood spotted with white deposits is richest in Catechin and that such wood is more prevalent in Oudh than in Burma shows that environment has a distinct bearing on the formation of the compounds here dealt with. From the fact that Catechu tannin is soluble, while Catechin is nearly insoluble, in cold water (a fact originally pointed out by Etti), **Dr. Warth** was enabled to separate these two substances. The concentrated decoction was by him simply set aside for five days, to allow of the formation of the crystalline Catechin. Cold water was then added and the solution filtered. By this simple contrivance Catechin was separated and the filtrate

subsequently boiled down to form Cutch. It is possible that it may be by some such process that some of the *Kath* sold in India is prepared from the crude Cutch, since it is hardly admissible that the whole of the *Kath* consumed can be derived from the comparatively limited production in Kumaon. If this supposition be not correct it might be possible to organise a fairly remunerative industry in refining *Kath* from Cutch. But it may be pointed out that Dr. Warth has not touched on the further question as to the possibility, by chemical or mechanical contrivances, of increasing the yield of Catechin, or at all events preventing its degeneration—points briefly indicated in the above review of the chemistry of the subject (p. 5).

Preparation of *Kath* from Cutch.

Conf. with p. 25.

The correspondence that ensued on the publication of Dr. Warth's proposal to found a central factory for the purpose of manufacturing *Kath* and Cutch is too extensive to be here given in full. It may, however, be stated that it was brought out that except in Burma and the Central Circle of the North-West Provinces, no forests of this tree exist which, within workable limits, could yield a sufficient quantity of mature Cutch-wood to supply permanently a *Kath* factory large enough to be remunerative.

Establishment of Kath factory.

Regarding the two chief centres of **Acacia Catechu** the following opinions were advanced.

In Upper Burma some extensive cutch forests exist in the Yaw and other side valleys of the Chindwin. These have not, however, as yet been sufficiently explored, and those in the Pyinmana district are already severely worked. The recommendation was strongly opposed to create a Government *Kath* factory in competition with a well-developed manufacture and trade of considerable magnitude, in which some of the leading European firms of Burma are largely interested. It was held that the competition in the article in question was already very keen, and that it may be taken for granted that improvements in manufacture will be readily accepted by those interested without Government taking any further action than to institute investigations.

Supply in Burma.

As regards the North-Western Provinces, it was brought out that **Acacia Catechu** occurs in a belt of *khair*-bearing land which underlies the sál-producing Terai forests and occupies the Duns, and which extends from the Jumna far into Assam. This area narrows or widens with the general formation of the country, and, following the banks of rivers, frequently extends far into the Terai. The forest has no doubt always been mutilated and frequently destroyed by incessant firing; but even in the latter case dead stumps and other traces of the original forests can be found almost invariably; and where the forests have been protected, they have rapidly regained possession of the soil and produced a crop of considerable density. The area of Government forests in the Kumaon district, which is still in occupation of the *khair* tree, is estimated by the Conservator of Forests to aggregate 50,000 acres. The **Acacia Catechu** is by no means a small tree by nature, but is often dwarfed by continuous maltreatment.

Supply in N.-W. Provinces.

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Further experiments.

In the correspondence alluded to the very important remark was made "that results are frequently obtained in a laboratory which cannot be realized when dealing with large quantities." It was consequently proposed that further experiments be made with **Dr. Warth's** process on a somewhat extended scale. It was suggested that these experiments might be carried out at Dehra and it was held that it would be easy to calculate the saving which can be effected by cutting the wood with machinery, and consequently it was agreed that for the present such machinery need not be procured. But in Burma where such experiments were made some time ago, it was found the saving in chopping the wood by machinery was more than absorbed by the transport of the logs in bulk. It was regarded as desirable at least for the present to leave the use of vacuum pans out of consideration, and the only plant which it was thought necessary for the experiments were some copper vessels and a filter-press.

From the correspondence that ensued regarding the proposal to form a central factory the following extracts may be given, since these appear to either amplify the published information or raise points for future enquiry. The Conservator of Forests, Assam (letter No. 63 A., June 9th, 1892), wrote :—

Assam opinion about Central Factory.

"Dr. Warth's figures relating to the outturn of catechin and cutch obtained from both inferior and good woods, show that he procured from 14 to 24 per cent. of extract from the raw material, a far larger proportion than is obtained by the rough working process in vogue at present, by which the proportion of extract yielded is only about one-sixteenth, or 6 per cent. of the wood used. It has also been suggested by a Calcutta firm having large dealings in Burma cutch that this produce as manufactured by the vacuum pan process, being quite free of catechin, would be much less valuable for dye purposes than the cutch prepared in the rougher manner, as in Burma and elsewhere, by which a large proportion of the catechin is retained in the cutch ; and it is certainly strange that, in the North-West Provinces, where catechin alone is made, the cutch residue is considered of no account and not worth preserving ; while in Burma, where I believe cutch only is prepared, no attempt is made to extract the catechin.

"The two distinct practices certainly suggest that when either product is divorced from the other, one only retains a market value."

"Before concluding this report, it may be well to state that the departmental experiments hitherto made in extracting cutch from Darrang *Khair* have not been financially successful. In 1890, 50 maunds were made at a cost of ₹3,700, and as only ₹539 were realised for the same, this experiment resulted in a loss to Government of ₹3,160. It would be unfair, however, to debit the whole of the expenditure to the above outturn, because it included a considerable outlay on the pay and travelling expenses of three cutch boilers brought over from Burma and on the purchase of stores, erection of sheds, etc, But when such items are deducted from the total cost, there still remains a balance of ₹1,716 to be debited against the experiments on account of labour alone, or more than three times the return realised from the produce sold. This last season five maunds were specially made for the Economic Reporter for ₹100, or ₹20 per maund, which shows a great reduction on the cost of the former year, but which is still nearly double the selling price of the article. So far, therefore, we cannot be said to have proved that cutch-boiling can be carried on in the Assam forests with much chance of success.

Failure in Assam.

and of Kath. *(G. Watt.)*

Proposed working of Assam forests.

"It may also be noticed that a Calcutta firm has offered to work our *Khair* forests on the following conditions:—

(1) That a monopoly be given them for five years.
(2) That at the end of the five years, option to extend their exclusive right of working for another five years be granted.
(3) That on the expiration of the lease granted under (2) a first refusal be given the firm on whatever terms the Assam Government may impose, provided that they pay Government R1 per mature tree felled, or in the event of lease (2) being granted, that they pay a minimum sum yearly of R5,000 at the rate of R1 per tree, provided mature trees are available.

"I should be inclined to recommend the latter method of working the forests to attempting any further experiments departmentally; but would fix the royalty at R2 per mature tree of 4 feet girth. Before, however, inviting private enterprise to step in and work for us, I think we should await Dr. Warth's opinion on the resources at our disposal mentioned in this report."

Resources of Assam forests.

The resources to which the Conservator of Forests in Assam alludes are as follows:—

Area of Khair Forests in Assam.

Goalpara	9,000	acres.
Kamrup	5,000	,,
Darrang	4,480	,,
	18,480	acres.

At present capable of yielding per annum:—

Goalpara	trees of 4 feet and over	2,000
Darrang	trees of 3 feet and over	1,600

And allowing a margin for the timber of the above damaged by fire and not available for cutch-making, it may be roughly estimated that the yearly outturn of raw material obtainable from the above would equal about 46,000 cubic feet or 23,000 maunds.

Burma opinion on Warth's suggestions.

The Conservator of Forests, Pegu Circle, Burma (in letter No. 809, dated 13th October 1892), reported that—

"As the quantity of Catechin seems to vary directly with the occurrence of white spots in the wood, and the solidity and market value of Cutch also varies with the prevalence of white spots in the wood from which Cutch is extracted, it seems probable that the solidity and greater market value of Cutch depends upon the quantity of Catechin it contains. If this be the case, to extract the Catechin would be to greatly lower the value of the main product Cutch, and so far as Lower Burma is concerned, I doubt the advisability of making any experiments with a view to separate Catechin from Cutch, for even if the value of the Cutch were not greatly reduced it would be difficult to introduce a new process of manufacture and to do away with the use of iron pans now employed.

Conf. ante pp. 16, 19.

"I presume too that demand for Cutch is limited, and that a greater production would certainly result in a decrease of price."

Samples of Cutch were procured from Burma and submitted to the Assistant Agricultural Chemist to the Government of India, who furnished the following report:—

ACACIA Catechu.

Analysis of Burma Cutch.

The Isolation of Cutch,

RESULT OF CUTCH ANALYSIS—*Burma Samples.*

	(*a*)	(*b*)	(*c*)	(*d*)	(*e*)	(*f*)	(*g*)	(*h*)
	Tablets (W. C.) from Sinbyukyun, Rangoon price R60 viss.	Tablets (W. C.) from Myingyan, Rangoon price R80 viss.	Tablets (W. C.) from Sallamys, Rangoon price R58 viss.	Block (W. C.) from Tabekin, Rangoon price R57 viss.	Block (W. C.) from Pakôkku, Rangoon price R57 viss.	Block (P. C.) from Thayetmyo, Rangoon price R57 viss.	Block (P. C.) from Paungdé, Rangoon price R57 viss.	Block (E. C.) from Mandalay, Rangoon price R57 viss.
Moisture	17·3	22·7	12·0	29·9	18·2	27·1	15·3	17·4
Catechin	11·1	15·8	13·6	12·5	12·7	19·0	11·3	13·0
Tannin	68·8	61·3	73·9	56·1	68·8	53·5	72·1	68·2
	97·2	99·8	99·5	98·5	99·7	99·6	99·7	98·6

	(*i*)	(*j*)	(*k*)	(*l*)	(*m*)	(*n*)	(*o*)	(*p*)
	Soft (E. C.) from Mandalay, Rangoon price R45 viss.	Soft (P. C.) from Paungdé, Rangoon price R45 viss.	Soft (P. C.) from Thayetmyo, Rangoon price R45 viss.	Soft (P. C.) from Prome, Rangoon price R45 viss.	Soft (E. C.) from Pyinmana, Rangoon price R45 viss.	Soft (E. C.) from Meiktila, Rangoon price R45 viss.	Block (E. C.) from Pyinmana, Rangoon price R55 viss.	Block (E. C.) from Kambalu, Rangoon price R57 viss.
Moisture	41·9	27·2	27·3	31·3	30·4	33·8	36·5	37·0
Catechin	10·5	9·7	12·2	13·7	15·3	9·2	10·3	11·8
Tannin	46·4	60·5	59·5	54·4	52·1	56·1	51·1	51·0
	98·8	97·4	99·0	99·4	97·8	99·1	97·9	99·8

NOTE—

E. C. for Eastern Circle.
W. C. for Western Circle.
P. C. for Pegu Circle.

Analysis of Burma Cutch.

These analyses manifest an extraordinary range in composition of ordinary Pegu Cutch. In sample (*c*) there was 12·0 moisture (—a tablet of Cutch valued at ₹58 per viss), while in (*i*) there was 41·9 (—a sample of soft Cutch valued at ₹45). The range of Catechin was found to be similarly very great; sample (*j*) 9·7 Catechin (soft Cutch valued at ₹45) and (*f*) 19·0 (block Cutch valued at ₹57). It would also appear that in amount of Catechin found in the produce the three Forest Circles of Burma are very similar, thus the three highest were (*f*) from Pegu, (*b*) from the Western, and (*m*) from the Eastern Circle.

Turning now to the proportion of Catechu tannin the extremes were sample (*c*) 73·9 (a tablet valued at ₹58) and (*i*) 46·4 (soft Cutch valued at ₹45), also (*p*) 51·0 (a block Cutch valued at ₹57). There was thus remarkably little difference between the price paid for the sample with the highest amount of Catechu tannin and those with the lowest proportion of that substance. In what, then, lies the superiority? Sample (*b*) that fetched the highest price in the series has considerably more moisture than either (*a*) or (*c*) and it has less Catechu tannin but more Catechin than either of these. But sample (*f*) has considerably more Catechin than (*b*), though it fetched ₹23 per viss less, and (*m*) has the same amount of Catechin as (*b*), though it fetched little more than half the price. Sample (*k*) fetched the same price as sample (*n*), though it was found to contain 3 per cent. more Catechin and 3 per cent. more Catechu tannin.

The highest priced sample (*b*), valued at ₹80 per viss, manifests chemically nothing to justify its valuation. It is thus significant that the chemical analysis of an article which owes its merit to the presence of certain definite compounds should thus be at complete variance with commercial valuation. This result would thus appear to throw some doubt on the opinion advanced by the Conservator of Forests, Pegu, *viz.*, that the removal of Catechin would considerably lower the value of crude Cutch. This may be so, but the reason why has not as yet been demonstrated. It is true that the highest prices recorded above are for samples with a high yield of both Catechin and Catechu tannin, but even in this respect the valuations are not consistent:—

Conf. with pp. 16, 17.

	(*b*) ₹80.	(*a*) ₹60.	(*c*) ₹58.	(*f*) ₹57.	(*h*) ₹57.	(*k*) ₹45.
Catechin	15·8	11·1	13·6	19·0	13·0	12·2
Catechu tannin	61·3	68·8	73·9	53·5	68·2	59·5
	77·1	79·9	87·5	72·5	81·2	71·7

The highest priced article, if its merit lies in the total percentage of these two articles collectively, would have to be placed fifth in the above six examples. But it is difficult to see in what way an article like Catechin which is insoluble in cold water can materially assist the dyer and tanner unless it be changed into a soluble substance at some stage of the industrial uses to which it is put.

ACACIA Catechu.

The Isolation of Catechu,

N.-W. Provinces: Opinion on Warth's report.

Mr. J. S. Gamble, *Director of the Imperial Forest School,* in a communication (No. 53, dated 3rd August 1893) furnished an instructive statement of the investigations up to that date. The following paragraphs may here be given of **Mr. Gamble's** contribution :—

I have the honour to reply to your No. 504 of 14th June 1893. I think it best to go over the whole subject in order to make matters somewhat clearer than they are, for I confess to have been a little puzzled about what is still required in regard to the *kath* experiments.

2. With your No. 164 of 9th March 1891 was circulated **Dr. Warth's** memorandum on the preparation of "*kath*" or pale Catechu, and this was followed by your No. 454 of 23rd June 1891, sending for the Forest School Museum samples of the "*kath*" prepared by **Dr. Warth,** as well as copies of his report on the yield given by five qualities of the wood from Oudh and Burma. Next year with your No. 323 of 16th May 1892 came ten more copies of these reports, and the request that I should arrange to continue the experiments at the Forest School, and also report my views on the subject especially as regards the details of the arrangements to be made and the plant necessary. Your letter was sent for opinion to the School Officers, and as Conservator of the School Circle I arranged for wood for the experiments and called for information as to the cost of cutting and delivery of *khair* wood in Dehra.

3. The Deputy Director and the Instructor who teaches Natural Science then submitted to me the following note :—

"We have considered this subject together and the following are our views thereon.

"Dr. Warth appears to have made conclusive experiments regarding the amount and quality of extract to be obtained from the different kinds of wood mentioned in his report, and we are of opinion that no School Officer can hope to improve on the experiments made by **Dr. Warth,** who is an expert in such matters. If it is proposed to make Catechin and Catechu tannin on a large scale on the lines laid down by **Dr. Warth,** the plant would apparently cost, at the present rate of exchange, over one lakh of rupees, and a special officer would be required to superintend the factory. **Dr. Warth's** experiments tend to show that Oudh would probably be the best place for a factory of this kind, the Oudh specimens being peculiarly rich in Catechin. It might, perhaps, be advisable to ascertain whether the Acacia wood available in Dehra Dún is of the kind specified by **Dr. Warth,** as being the best, *viz.*, that containing numerous white spots. In this case, and if this is the idea suggested in the Inspector-General of Forests' letter, a small experiment might be undertaken to ascertain whether it comes up to the Oudh wood. Two copper vessels costing £75 each (unless smaller ones could be substituted) would probably suffice, one filter press and a lathe to turn the wood into shavings. There is in our opinion no "*raison d' etre*" in experiments on a more extended scale being made in Dehra Dún, unless it be shewn that the Acacia wood of that district is quite as good as, and available in a quantity equal to, that of Oudh. In conclusion we wish to state that neither of us feel competent to undertake what must always be a difficult experiment in organic chemistry. To obtain a certain proportion of Catechin from a given weight of wood is probably not a difficult operation, but to ascertain the absolute quantity of Catechin contained in that wood is quite a different matter. This can only be done by an experienced chemist. **Dr. Warth's** note shows that it is the *heart-wood* which contains the white spots. It will probably be found that there are very few trees in the Dún which yield any considerable proportionof heart-wood, owing to their small size."

4. The Deputy Conservator, Dehra Dún Division, in his letter No. 312, of 17th December 1892, to the Conservator of Forests, School Circle, forwarded 20 cubic feet of the heart-wood of *Khair* and reported that the cost of cutting and delivery (exclusive of royalty) would amount to ₹31-4 per 100 cubic feet, or 5 annas per cubic foot. The Agricultural Chemist to the Government of India was then asked to experiment with this sample of

and of Kath. (*G. Watt.*)

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Dún wood, and I beg to submit copy of his report No. 13 of 27th January 1893. *

N.-W. Provinces: Opinion on Warth's report.

5. I now turn to the Assam correspondence. In his letter No. K. 92 of 6th July 1892 the Conservator of Forests, Assam, wrote as follows:—

"In a report lately submitted to the Government of India on the possibilities of working the Assam *Khair* forests on the lines indicated in Dr. Warth's report forwarded under Government of India, Revenue and Agricultural Department, Nos. 686 to 689 F., dated 17th June 1891, attention was drawn by me to the very large difference in the proportion of extract obtained from our wood by local experiment, on the rough Burma plan, and that obtained by Dr. Warth in his laboratory experiments. Naturally our experiment showed a much less yield, the figures being 6 per cent. of extract as compared with Dr. Warth's varying proportion of from 14 to 24 per cent.† I proposed therefore that several samples of our *Khair* wood should be sent to Dehra for analysis, and I now have the honour to enquire if you would kindly undertake the experiment. In the meantime I have ordered 15 sample sections of 2 cubic feet each, to be prepared with the bark on, which will be despatched as soon as practicable, after I receive your reply. Please be good enough to state if samples half the above size would be large enough."

* See above, p. 18.

† See above, p. 13.

In reply I wrote: "Dr. Warth is no longer in Dehra, and it is rather doubtful if there is any body at present capable of conducting experiments in the way he did; we will, however, see if we can manage it, and I would suggest your sending only a few samples of one cubic foot each at first." None have, however, yet come to hand, so that I have been unable to furnish the report called for in your No. 804 of 27th September 1892.

6. Then came the Burma correspondence. Your endorsement No. 955 of 5th November 1892 communicated to me the request made by you to the Conservator of the Pegu Circle to send some samples (say, 25lb each) of Burma Cutch of different market values to this institution to be analysed by the Agricultural Chemist in order to ascertain the quantity of Catechin which each sample may contain. In February 1893 the specimens of cutch duly arrived, the boxes being marked A. to P.‡

‡ For report see above, page 18.

Report by the Agricultural Chemist.

The specimens were handed over to Mr. Collins, Assistant Agricultural Chemist, in the absence of the Agricultural Chemist, and Mr. Collins was at work on them when he was ordered off to Poona. Dr. Leather informs me that his enquiries are not yet completed and cannot be completed until Mr. Collins returns.

The enquiry into this subject was then undertaken by Dr. Leather, Agricultural Chemist to the Government of India, who furnished two valuable contributions that may now be given—

As requested by you I have examined the sample of Dehra Dun wood, **Acacia Catechu**, which was sent to the Imperial Forest School, I understand that you wished to know (1) how much crude Catechin and Catechu tannin is contained in this wood, (2) by what process these substances might be most readily separated.

2. In principle I have adopted the same method as that used both by the Cutch boilers and also by Dr. Warth, that is, the wood is first reduced to small pieces, it is then boiled in water, the decoction separated, boiled down and the concentrated extract set aside for the purpose of allowing the Catechin to crystallise out. The crude Catechin is then separated from the liquid portion, washed with cold water and dried. The liquid from which the crude Catechin has been separated is heated gently until the

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water is practically evaporated off and the residue contains the Catechu tannin.

3 *The total amount of crude Catechin* I found to be 7·18 and 6·43 per cent. in two experiments respectively, and of crude Catechu tannin 7·61 and 9·02 per cent., the total extract amounting to 14·79 and 15·45 per cent.

4. Regarding the most suitable method by which these substances may be extracted I have experimented (*a*) on the *form* in which the wood should be used, (*b*) the amount of water with which it should be boiled, (*c*) whether a hard or a soft water is preferable, (*d*) for how long the boiling should continue.

5. (*a*) *The form in which the wood should be used.*—The native Cutch-maker, I understand, chops the timber up with an axe. Dr. Warth in his experiments cut the wood up with a lathe. In these cases the pieces are of some little thickness and, as will be readily understood, unless the water has an opportunity of entering the cells, all the Catechin and Catechu tannin cannot be brought into solution. Dr. Warth's method is undoubtedly preferable to that of the natives and his results bear this out, for whilst the latter cannot (from *this* sort of **Acacia Catechu** timber) extract any appreciable amount of Catechin, the former obtained up to five per cent.

6. Touching this point I have experimented with the wood in the form of (1) chips $\frac{1}{4}'' \times \frac{1}{4}'' \times \frac{1}{4}''$, (2) saw-dust, (3) shavings $\frac{1}{50}''$ to $\frac{1}{70}''$ thick obtained with the plane. From the results shown in Table I, it will be seen that the amounts both of crude Catechin and also of crude Catechu tannin are very small, about a quarter of the total amount, when the wood is employed in the form of chips. Both shavings and saw-dust gave much higher results. It is to be observed, however, that it would be practically impossible to reduce wood to the form of saw-dust, and, were it possible, it is with considerable difficulty that the saw-dust, after boiling, is separated from the aqueous extract. From the shavings the liquid may be readily poured, and it is from them that I have obtained the best results.

7. *The amount of water which should be used.*—Dr. Warth recommends that the wood be boiled with twenty times its weight of water. It will be clear that, *cæteris paribus*, the less water that is required the better, for after the extracting process is completed all the water which has been used must be evaporated again, for which fuel is required. In my experiments I have used as small a quantity as two parts of water (Table I "Chips") and have still obtained approximately as much Catechin as when twenty parts of water were used. This result was obtained from *Chips*. When boiling *shavings*, however, I found that it was not practicable (owing to their volume) to use less than ten parts of water. Nevertheless the results of all the experiments show that the use of a less quantity of water than twenty times the weight of wood used is not detrimental to the process.

8. *The description of water to be employed.*—From Table II it will be seen that the canal water (which contained 49·28 grains of solid matters per gallon, most of which was gypsum) extracted as much as pure water, and it would seem therefore to be immaterial to the process whether the water used be hard or soft.

9. *The time required for extraction.*—The native Cutch-maker boils the wood for some hours. In my experiments the wood was boiled for half an hour only and I have every reason to believe both from my experience with this wood, as also from my general knowledge of the time required to perform such operations, that this time is sufficient. In any case it is desirable to reduce the time as far as practicable.

10. *The time required to cut up the timber into shavings.*—A log of the Burma **Acacia Catechu** was cut up, one half into shavings with the plane,

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the other half into chips with the hatchet. A carpenter was employed for this. The weight of the log was 10 seers, of which 4 seers was reduced to shavings in two hours. The remainder, weighing 6 seers, was then cut into chips by the same man in seven hours. I was surprised at this result, for I had expected it would require a longer time, not a shorter, to cut up the wood with the plane. Whether a similar result would be attained by other men I cannot say, but the experiment shows that it would not take a longer time to cut the timber into shavings than into chips.

11. Having regard then to the results of the several experiments which I have made, I draw the following conclusions :--

1. That whether the Cutch extraction be performed by the native or in a factory, the wood should be preferably reduced to thin shavings.
2. That as little water be used as may be, ten parts or perhaps less would suffice.
3. That the boiling be continued for half an hour only.

TABLE I.

	Ratio. Wood : Water.	Crude Catechu-tannin.	Crude Catechin.	Total Extract.
Shavings	1 : 10	7·61	7·18	14·79
	1 : 20	9·02	6·43	15·45
Saw-dust	1 : 10	5·36	4·16	9·52
	1 : 20	9·30	2·72	11·92
	1 : 20	8·10	4·90	13·00
	1 : 20*	7·40	6·20	13·60
Chips	1 : 20	3·48	0·83	4·31
	1 : 10	3·29	1·23	4·52
	1 : 5	3·04	1·75	4·75
	1 : 5*	2·04	1·75	3·79
	1 : 2	1·30	1·22	2·52
	1 : 2	1·62	1·60	3·22

* Distilled water was used for these two extractions.

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TABLE II.

	Ratio. Wood. : Water.	Crude Catechu-tannin.	Crude Catechin.	Total Extract.
Saw-dust	1 : 20 (Canal-water.)	8·1	4·9	13·0
	1 : 20 (distilled water.)	7·4	6·2	13·6
Chips	1 : 5 (Canal-water.)	3·05	1·75	4·8
	1 : 5 (distilled water.)	2·04	1·75	3·79

The three conclusions arrived at by **Dr. Leather** are likely to be regarded as of considerably more practical value than the results obtained by **Dr. Warth**, since State factories are not likely to be undertaken. The labour employed by the native manufacturer is, however, scarcely likely to be easily taught the superior merits of the plane for many a long day. But the advantage of less water and consequently less boiling are two points that it might be possible to induce him to accept. By doing so there would not only be an economy of time and money, but, as shown by **Etti**, a saving in the amount of Catechin, since by continued heat a decomposition of that valuable ingredient must take place. The injury pointed out by **Dr. Warth** caused through the use of iron cauldrons is one that Government might become the pioneers in reforming by procuring copper cauldrons and hiring these out at a low price until the people had appreciated their value. This state of affairs is not unknown to the people of India. The distillers of *rusa*-oil, for example, regularly hire copper stills from the money-lenders and rarely possess their own apparatus.

The following further analyses have been furnished by **Dr. Leather**, Agricultural Chemist to the Government of India, (February 2nd, 1895) of six samples of North-West Himálayan (Dehra Dún) **Acacia Catechu** wood. "The figures in the statement below express parts per 100 parts of wood":—

Analysis of Dehra Dún Catechu Wood.

	I	II	III	IV	V	VI
	Shavings.	Shavings.	Shavings.	Shavings.	Shavings.	Shavings.
Catechin	0·47	0·97	3·07	3·61	2·5	3·38
Catechu-tannin	2·72	2·61	7·5	5·44	8·11	5·29
			Chips.	Chips.		
Catechin	...	...	1·91	2·93	...	...
Catechu-tannin	...	...	5·56	4·17	...	...

Report by the Agricultural Chemist.

"For the determination of the proportions of Catechin and Catechu-tannin, the wood was reduced to shavings by means of the carpenter's plane. In this form the *total* amounts of these ingredients can be determined, whereas if the wood is reduced to 'chips', only a portion of these matters is extracted. With a view to determine the latter, a portion of Samples III and IV were reduced to chips with the hatchet and the amounts of Catechin and Catechu-tannin determined in them. The results thus obtained are placed in the lower half of the statement. The quantity of wood sent was not sufficient to make similar determinations in 'chips' of the other four samples. It would be better to send samples of wood 18″ long in future. Although the amounts of Catechin and Catechu-tannin are very much less than was found in the sample of wood submitted to me in December 1892, their analyses show a similar difference in amounts of extractable substances, which are smaller when they are extracted from the wood in 'chip' form, than when it is reduced to 'shavings'.

Causes of variation in yield.

The very remarkable range in yield, between No. I and No. IV, in Catechin, and between No. I and No. V in Catechu-tannin, makes it extremely desirable that in all future analyses it should be definitely ascertained what are the peculiarities of each sample about to be examined. It is impossible to suppose that so great a difference could be accidental. It must be due to some such causes as age of trees, nature of soil, health or disease of trees, season of the year in which felled, part of the stem from which taken, etc. Thus, for example, had we been told that No. I was a portion of wood taken from the outer zones of the heart-wood and No. IV from the more central, we would have been justified in definitely affirming that the latter zone was richer in Catechin than the former; in other words, that Catechin was a subsequent formation produced by a process of metabolism. It is certainly striking that the analyses as they stand should manifest the peculiarity that the highest yield of Catechin is not associated with the greatest quantity of Catechu-tannin; on the contrary, that a high yield of Catechin is associated with a comparatively small amount of Catechu-tannin. These observations, imperfect and unsatisfactory though they are, would seem to justify the emphatic opinion that we have hitherto made but accidental and disconnected investigations, and that to accomplish the object aimed at we must give the subject more careful consideration. It is necessary not only to work out the chemical changes that take place in the various systems of manufacture (pursued by the people of India), but to clearly ascertain the various changes that occur within the tissues of the plant before the deposition of Catechin takes place. A definite knowledge of these changes should not only suggest the proper season and method of felling, cutting up and boiling, but might afford the key to our being able to continue these changes in the factory, if that be at all attainable, so as to secure economies of great practical value.

Concluding Remarks.

Concluding remarks. *Conf. with p. 14.*

In the subsequent correspondence that ensued on this subject, the author of this review suggested that the secret which the Kumaon workers are said to husband so carefully, might be in the direction

Secret of Kumaon *kath* makers.

of converting a large proportion of the Catechu-tannin into Catechin. That suggestion was, however, purposely guarded as a mere speculation and one founded mainly on the observation that within the tissue of the plant this appears to be the order of formation. The highest percentage of Catechin would seem to be found in old trees and imbedded within the mature heart-wood; the greatest abundance of Catechu-tannin in young trees or less lignified structures. The writer further suggested that it was difficult to believe that the Kumaon manufacturers should deliberately drain off the liquid that contains, or is supposed to contain, the soluble Catechu-tannin, when its retention would so materially increase the bulk of the article they manufacture, or might be sold separately. It was pointed out at the same time that there should be no difficulty in putting these surmises to practical test. For example, a quantity of the sand which the Kumaon manufacturers use as their filter should be found rich in Catechu-tannin if it be the case that they remove only the crystalline Catechin, in the manufacture of *kath*, and reject the Catechu-tannin as useless. The writer also suggested another method of testing this doubtful point. The yield of *kath* to the weight of wood should give some indication of whether the Kumaon system utilized only a portion of the contained tannin material. If higher than the chemical results we should be justified in believing that they actually do convert some portion of the Catechu-tannin into Catechin. So in a like manner the price at which Kumaon *kath* is sold, as compared with Pegu Cutch, should give some indication, since the former, if it consists of only the proportion of Catechin found by the Chemist in the wood, should be considerably more than twice the value of the Pegu article.

These suggestions led to some further communications, though up to date it cannot be said that all the difficulties with which the cutch and *kath* industries are involved have been satisfactorily solved. The question as to weight of cutch and *kath* to the wood used has, however, been answered, though the answers appear to be conflicting. The Conservator of Forests, Central Circle, North-West Provinces, wrote (letter No. 168—dated 7th August 1894)—

Experiments in N. W. Provinces.

"The experiments made in this Circle show that a cubic foot of wood yields in the hands of the Khairiahs a quantity of Cutch varying from 0·6 ℔ to 2·6℔. For practical purposes it may be accepted that the outturn per cubic foot of trees, such as are found in the Bhabor, varies from 1 to 2½ ℔ the difference being more due to the complete or incomplete boiling and using up of the material than to the varying quality of the wood."

"In suitable localities where the conditions are favourable, the Khairiahs take care to boil down all the Cutch-producing wood, whereas where the opposite is the case, much is wasted and left lying in the forest."

"From the above I consider the high rate of 2½ ℔ per foot is the proper yield, deduced from the cubical contents of the tree, or say a little more than half that obtainable from the heart-wood only."

On this subject the Conservator of Forests, Pegu, wrote (letter No. 916, dated 8th August 1894) "that to produce a maund (82 ℔) of Cutch 20 cubic feet of wood are required; this quantity of wood includes sapwood estimated to be 25 per cent of the whole quantity."

"It has also been ascertained that the same quantity (82℔) of Cutch is produced from 917 ℔ of wood (heart-wood only)."

Improvements in the manufacture possible.

It will be observed that it is not expressly stated, regarding the yield in the North-West Provinces, whether *kath* is meant, but it may be assumed that it is so and in that case the yield is considerably higher, relatively speaking, to that in Pegu than it ought to be. But there now appears to be no doubt that the manufacture in Kumaon is an extravagant one, a large quantity of valuable Catechu-tannin being regularly thrown away. We have by no means, however, learned all that we require to know, but enough has been elucidated to show that great economies and improvements are possible.

The Editor, in the official correspondence from which this review has been compiled, also suggested a further line of enquiry, *viz.*, whether it was possible the yield of Catechin was increased by mechanical or other injuries to the growth of the plant. The replies received would repudiate this suggestion on the ground—

Extraction of Catechin by ways other than boiling.

"that it appears to be improbable that Catechin could be drawn from the trees by wounding them, for it is a solid substance found in the heart-wood"—*Dr. Leather.* So again (Director, Imperial Forest School, No. 85, dated 30th September 1894): "If Catechin were a gum obtained by exudation and chiefly from the sapwood, no doubt wounding the trees would increase the production, but it is not a gum, but a substance found in the heart-wood, and wounding could have little or no effect. As regards diseased trees I will shortly try to find some and hand the wood over to the Agricultural Chemist for analysis."

But it may be pointed out that removal of gum or any other mechanical disturbance to the life of the plant through wounds, diseases, drought, etc., might easily enough cause a deposition of the crystalline matter within the wood. The irritation caused by sand within the oyster shell is believed to be the exciting cause to the formation of the pearl. Barus camphor is deposited within the wood of **Dryobalanops Camphora** very much after the same manner as catechin (*khirsal*) within that of **Acacia Catechu.** The crystals of that form of camphor are well known to occur within the heart-wood, hence it is said old trees are the most productive. In searching for trees likely to yield camphor, the Natives pierce the stems to the heart-wood, thus injuring them materially; but it is said that a tree left for seven or eight years will then be found to contain deposits of camphor freely, so that the tapping process has come to be regarded as facilitating the formation of the much-prized article. The formation *Agar* (a crystalline substance found within the wood of **Aquilaria Agallocha**) is believed to be due to some diseased condition. The formation of the crystalline substance *tabáshír* within the bamboo has been demonstrated to be due to an insect. A Native merchant (according to Mr. Peppe) tried to imitate the action of the insect, with the result that he found that by making a small perforation above a joint in half-mature bamboos the salt formed freely. This he practised systematically and made a considerable sum of money before he finally glutted the market with *tabáshír.* (*Dict. Vol. I, 385*). It is not unusual in fact in agricultural operations to check the growth of plants so as to cause the formation of reserve materials. In the production of *ganja* it is found necessary to remove the male plants since the fertilization of the female destroys the formation of the narcotic. But in some

Points for investigation.

parts of the country (as in Burma) this same result is obtained by injuring the stems. Without mentioning other such examples it may fairly well be said that it remains to be demonstrated that the yield of Catechin is not a matter that is capable of control. It was, however, from analogy in similar instances that the writer ventured to make the suggestion that the formation of Catechin might be facilitated by mechanical agencies or other disturbances to the life of the plant. This, however, was only a suggestion, though it is one that might still be kept in view. The most important points that remain to be definitely determined are (*a*) the chemical changes that take place within the tissue of the plant (during the formation of Catechin); (*b*) to continue the enquiry into the subject of a simple means of causing the formation of Catechin either within the tissue of the plant or during the process of manufacture; (*c*) to ascertain the age of the trees at which that substance is most freely formed and, if expedient, to frame a system of forest conservancy based upon the knowledge thus obtained; (*d*) to establish the nature of the environment most favourable to its production, and hence to draw up a map of India that would show the distribution of **Acacia Catechu** and the tracts within that area where Catechin might be manufactured and those in which the cruder article only could be produced; (*e*) to determine the nature and yield of the Catechu compounds obtained from the other species of **Acacia** that are reputed to afford these substances; (*f*) to elaborate a more exact and scientific method of manufacture than that which prevails, and one which could be adopted by the *Khair* workers; (*g*) to have a series of comparative experiments performed in both Burma and Kumaon, to ascertain whether the Native methods pursued in these centres of the trade, respectively, are interchangeable or are direct natural evolutions of local conditions that cannot be practised elsewhere; and lastly, to instruct the Kumaon *Kath* workers in the loss they sustain (if the loss be serious) through the rejection of the liquid that remains after the crystallization of the article for which they are famed.

IN CAMP ASSAM:
March 25th, 1895.

GEORGE WATT.

A. 135—199.

G. I. C. P. O.—No. 2 R. & A.—9-7-95.—2,000.—De'S.

All communications regarding THE AGRICULTURAL LEDGER should be addressed to the Editor, Dr. George Watt, Reporter on Economic Products to the Government of India, Calcutta.

The objects of this publication (as already stated) are to gradually develop and perfect our knowledge of Indian Agricultural and Economic questions. Contributions or corrections and additions will therefore be most welcome.

In order to preserve a necessary relation to the various Departments of Government, contributions will be classified and numbered under certain series. Thus, for example, papers on Veterinary subjects will be registered under the Veterinary Series; those on Forestry in the Forest Series. Papers of more direct Agricultural or Industrial interest will be grouped according as the products dealt with belong to the Vegetable or Animal Kingdom. In a like manner, contributions on Mineral and Metallic subjects will be registered under the Mineral Series.

This sheet and the title-page may be removed when the subject-matter is filed in its proper place, according to the letter and number shown at the bottom of each page.